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मानक

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IS 3748 (1990): Tool and Die Steels [MTD 16: Alloy Steels and Forgings]



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“Knowledge is such a treasure which cannot be stolen”

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भारतीय मानक
औजार और डाई इस्पात — विशिष्टि
(दूसरा पुनरीक्षण)

Indian Standard

TOOL AND DIE STEELS — SPECIFICATION

(Second Revision)

Third Reprint MARCH 2006
(Including Amendment No. 1 and 2)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards on 20 March 1990, after the draft finalized by the Alloy Steels and Special Steels Sectional Committee, had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1966 and was revised in 1978. As a result of the experience gained during these years in the production and use of steels, the concerned Sectional Committee has decided to revise this Indian Standard merging it with IS 3749 'Specification for tool and die steel for cold work'. In this revision, therefore, the requirements of various grades of IS 3749 have also been incorporated.

The grades meant for cold work are used for making tool and die for blanking, trimming, chipping and shearing.

The primary requirement of tool and die steels for hot work is the maintenance of the hardness at high temperatures. They usually contain 0.30 to 0.40 percent carbon and the normal working hardness is about 44 to 52 HRC. The 5 percent chromium group is normally operated between 370° to 590°C. The red hardness increases with the amount of alloying elements especially tungsten, chromium, molybdenum and vanadium. As these steels have high resistance to cracking due to thermal cycling, they may be subjected to intermittent cooling.

Typical uses of hot work grades are die-casting, dies for aluminium, magnesium and zinc, hot headers for rivets, bolts, up setter dies, etc. The tungsten base steels have better red hardness than the 5 percent chromium group and could be operated at 425° to 650°C, but these steels have less resistance to heat checking and, therefore, should not be subjected to intermittent cooling. Typical uses of these grades are extrusion dies, not-swaging dies, forging die inserts, brass forging dies, hot shear blades, trimmer dies, die-casting dies for copper, etc. For best results these steels should be pre-heated to 150-300°C before use as their toughness-transition temperature lies in that range.

Annex A gives particulars to be specified by the purchaser while ordering for steels covered in this standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

AMENDMENT NO. 1 SEPTEMBER 1994
TO
IS 3748 : 1990 TOOL AND DIE STEELS —
SPECIFICATION
(Second Revision)

(Page 2, Table 1, col 10 and 11, under sulphur and phosphorous headings)
— Insert 'Max'.

(Page 2, Table 1, col 1) — Insert the following after the grade T90V2:

Designation	C	Si	Mn	Ni	Cr	Mo	V	W	S	P
'T103 V2	0.95-1.10	0.10-0.30	0.40 Max	—	—	—	0.15-0.30	—	0.035	0.035'

(MTD 16)

Printed at Prabhat Offset Press, New Delhi-2

**AMENDMENT NO. 2 JUNE 1999
TO
IS 3748 : 1990 TOOL AND DIE STEELS —
SPECIFICATION**

(*Second Revision*)

(*Page 2, Table 1, col 3, row 6*) — Substitute '0.10 -0.35' for '0.10 - 0.65'.

(MTD 16)

Printed at Prabhat Offset Press, New Delhi-2

Indian Standard

TOOL AND DIE STEELS — SPECIFICATION

(Second Revision)

1 SCOPE

1.1 This standard covers the requirement for plain carbon and alloy tool and die steel in the form of bars, blanks, rings and other shapes for cold work and hot working application capable of being hardened and tempered.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
228	Methods of chemical analysis of steels (<i>second revision</i>) (in parts)
1500 : 1983	Brinell hardness test for metallic materials (<i>second revision</i>)
1956 (Parts 1 to 8)	Glossary of terms relating to steel
3664 : 1981	Code of practice for ultrasonic pulse echo testing by contact and immersion methods (<i>first revision</i>)
3703 : 1980	Code of practice for magnetic particle flaw detection (<i>first revision</i>)
3711 : 1966	Selection and preparation of samples and test pieces for mechanical test for wrought steels
3739 : 1987	Dimensional tolerances for carbon and alloy constructional steel products (<i>first revision</i>)
10138 (Part 1) : 1982	Macroscopic method for determination of non-metallic inclusion content in wrought steel: Part 1 Blue fracture test method
10138 (Part 2) : 1983	Macroscopic method for determination of non-metallic inclusion content in wrought steel: Part 2 Step mechanical test method
10138 (Part 3) : 1983	Macroscopic method for determination of non-metallic inclusion content in wrought steel: Part 3 Magnetic particle inspection method

IS No.

Title

10604 (Part 1) : 1983	Machining allowance and tolerance for open die steel forgings: Part 1 Carbon and low alloy steel forgings
10604 (Part 2) : 1983	Machining allowance and tolerance for open die steel forgings: Part 2 High alloy steel forgings
11371 : 1985	Method for macroetch test for wrought steel products
12211 : 1988	Micrographic method for assessing the distribution of carbides in tool steels and bearing steels using reference photomicrographs

3 TERMINOLOGY

3.1 For the purpose of this standard, definitions given in relevant parts of IS 1956 shall apply.

4 SUPPLY OF MATERIALS

4.1 General requirements relating to the supply of the material shall conform to IS 8910 : 1978.

4.2 Steels covered in this standard shall be ordered and delivered on the basis of (a) Chemical composition, or (b) chemical composition and the hardness in the annealed condition.

5 MANUFACTURE

5.1 Unless agreed otherwise in the order, the processes used in making the steel and the product are left to the discretion of the manufacturer, but the steel shall be fully killed. When so desired, the purchaser shall be informed of the steel making process. However, for continuously cast steels and for steels in specially treated condition, like secondary refined, vacuum degassed, electroslag or electro-flux refined, etc, the steel-making process shall be agreed to at the time of enquiry and order. For continuously cast materials, the reduction ratio between the cast product and the final product shall be agreed to at the time of ordering.

5.2 Sufficient reductions and discards shall be made from each ingot to ensure freedom from piping, harmful segregation and other defects.

5.3 The material shall be rough machined, chipped or ground to remove all surface

imperfections which are likely to produce defects in the finished product.

5.3.1 If the material is conditioned by grinding or chipping, depth of conditioning shall not exceed half the machining allowance per side and width of conditioning shall be at least four times its greatest depth.

6 FREEDOM FROM DEFECTS

6.1 The material shall be free from harmful surface defects such as seams, laps, cracks. The material shall also be free from flakes.

6.2 Decarburization (total and partial) shall be kept at the minimum level and in no case shall exceed 80 percent of the machining allowance.

6.2.1 All materials supplied in machined and ground condition shall be entirely free from surface decarburization.

7 CHEMICAL COMPOSITION

7.1 The ladle analysis of steels shall be as given in Table 1. The analysis of steel shall be carried out either by the method specified in IS 228 and

Table 1 Chemical Composition, Percent
(Clauses 7.1, 7.2 and 12.1)

Designation	Carbon	Silicon	Manganese	Nickel	Chromium	Molybdenum	Vanadium	Tungsten	Sulphur	Phosphorus
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
<i>For Cold Work</i>										
50T8	0.45-0.55	0.10-0.35	0.60-0.90	—	—	—	—	—	0.035	0.035
55T8	0.50-0.60	0.10-0.35	0.60-0.90	—	—	—	—	—	0.035	0.035
60T6	0.55-0.65	0.10-0.35	0.50-0.80	—	—	—	—	—	0.035	0.035
65T6	0.60-0.70	0.10-0.35	0.50-0.80	—	—	—	—	—	0.035	0.035
70T6	0.65-0.75	0.10-0.35	0.50-0.80	—	—	—	—	—	0.035	0.035
75T6	0.70-0.80	0.10-0.65	0.50-0.80	—	—	—	—	—	0.035	0.035
80T6	0.75-0.85	0.10-0.35	0.50-0.80	—	—	—	—	—	0.035	0.035
85T6	0.80-0.90	0.10-0.35	0.50-0.80	—	—	—	—	—	0.035	0.035
70T3	0.65-0.75	0.10-0.30	0.40 Max	—	—	—	—	—	0.035	0.035
80T3	0.75-0.85	0.10-0.30	0.40 Max	—	—	—	—	—	0.035	0.035
90T3	0.85-0.95	0.10-0.30	0.40 Max	—	—	—	—	—	0.035	0.035
103T3	0.95-1.10	0.10-0.30	0.40 Max	—	—	—	—	—	0.035	0.035
118T3	1.10-1.25	0.10-0.30	0.40 Max	—	—	—	—	—	0.035	0.035
133T3	1.25-1.40	0.10-0.30	0.40 Max	—	—	—	—	—	0.035	0.035
T80V2	0.75-0.85	0.10-0.30	0.40 Max	—	—	—	0.15-0.30	—	0.035	0.035
T90V2	0.85-0.95	0.10-0.30	0.40 Max	—	—	—	0.15-0.30	—	0.035	0.035
T31Ni10Cr3	0.27-0.35	0.10-0.35	0.40-0.70	2.25-2.75	0.50-0.80	0.40-0.70	—	—	0.035	0.035
T118Cr2	1.10-1.25	0.10-0.30	0.40 Max	—	0.30-0.60	—	0.30 Max	—	0.035	0.035
T135Cr2	1.25-1.40	0.10-0.30	0.40 Max	—	0.30-0.60	—	0.30 Max	—	0.035	0.335
T105Cr5	0.90-1.20	0.10-0.35	0.20-0.40	—	1.00-1.60	—	—	—	0.035	0.033
T105Cr5Mn2	0.90-1.20	0.10-0.35	0.40-0.80	—	1.00-1.60	—	—	—	0.035	0.035
T140W15Cr2	1.30-1.50	0.10-0.35	0.25-0.50	—	0.30-0.70	—	—	3.50-4.20	0.035	0.035
T60Ni5	0.55-0.65	0.10-0.35	0.50-0.80	1.00-1.50	0.30 Max	—	—	—	0.035	0.035
T40Ni14	0.35-0.45	0.10-0.35	0.50-0.80	3.20-3.60	0.30 Max	—	—	—	0.035	0.035
T30Ni16Cr5	0.26-0.34	0.10-0.35	0.40-0.70	3.90-4.30	1.10-1.40	—	—	—	0.035	0.035
T55NiCrMo3	0.50-0.60	0.10-0.35	0.50-0.80	1.25-1.75	0.50-0.80	0.25-0.35	—	—	0.035	0.035
T40Ni6Cr4	0.35-0.45	0.10-0.35	0.40-0.70	1.25-1.75	0.90-1.30	0.20-0.35	—	—	0.035	0.035
<i>Mo3</i>										
T31Ni10Cr3	0.27-0.35	0.10-0.35	0.40-0.70	2.25-2.75	0.50-0.80	0.40-0.70	—	—	0.035	0.035
<i>Mo6</i>										
T40Ni10Cr3	0.36-0.44	0.10-0.35	0.40-0.70	2.25-2.75	0.50-0.80	0.40-0.70	—	—	0.035	0.035
<i>Mc6</i>										
T105W6CrV2	0.90-1.20	0.10-0.35	0.40 Max	—	0.40-0.80	0.25 Max	0.20-0.30	1.25-1.75	0.035	0.035
T110W6Cr4	1.00-1.20	0.10-0.35	0.25-0.50	—	0.90-1.30	—	—	1.25-1.75	0.035	0.035
T90Mn6WCr2	0.85-0.95	0.10-0.35	1.25-1.75	—	0.30-0.60	—	0.25 Max	0.40-0.60	0.035	0.035
XT160Cr12	1.50-1.70	0.10-0.35	0.25-0.55	—	11.0-13.0	0.80 Max	0.80 Max	0.60 Max	0.035	0.035
XT215Cr12	2.00-2.30	0.10-0.35	0.25-0.50	—	11.0-13.0	0.80 Max	0.80 Max	Option	0.035	0.035
T55Cr3	0.50-0.60	0.10-0.35	0.60-0.80	—	0.60-0.80	—	—	—	0.035	0.035
T45Cr5Si3	0.40-0.50	0.80-1.10	0.55-0.75	—	1.20-1.60	—	—	—	0.035	0.035
T55Cr3V2	0.50-0.60	0.10-0.35	0.60-0.80	—	0.60-0.80	—	0.10-0.20	—	0.035	0.035
T50Cr4V2	0.45-0.55	0.10-0.35	0.50-0.80	—	0.90-1.20	—	0.15-0.30	—	0.035	0.035
T55Si7	0.50-0.60	1.50-2.00	0.80-1.00	—	—	—	—	—	0.035	0.035
T55Si7Mo3	0.50-0.60	1.50-2.00	0.80-1.00	—	—	0.25-0.40	0.12-0.20*	—	0.035	0.035
T40W8Cr5V2	0.35-0.45	0.50-1.00	0.20-0.40	—	1.00-1.50	—	0.10-0.25	1.75-2.25	0.035	0.035
T50W8Cr5V2	0.45-0.55	0.50-1.00	0.20-0.40	—	1.00-1.50	—	0.10-0.25	1.75-2.25	0.035	0.035
<i>For Hot Work</i>										
XT33W9Cr3V4	0.25-0.40	0.10-0.35	0.20-0.40	—	2.80-3.30	—	0.25-0.50	8.0-10.00	0.035	0.035
XT35Cr5	0.30-0.40	0.80-1.20	0.25-0.50	—	4.75-5.50	1.20-1.60	0.20-0.40	—	0.035	0.035
<i>Mo1V3</i>										
XT35Cr5MoV1	0.30-0.40	0.80-1.20	0.25-0.50	—	4.75-5.50	1.20-1.60	1.00-1.20	—	0.035	0.035
XT35Cr5Mo	0.30-0.40	0.80-1.20	0.25-0.50	—	4.75-5.50	1.20-1.60	0.20-0.40	1.20-1.60	0.035	0.035
<i>W1V3</i>										
XT55W14	0.50-0.60	0.10-0.35	0.20-0.40	—	2.80-3.30	—	0.30-0.60	13.0-15.0	0.035	0.035
<i>Cr3V4</i>										

*Optional (wherever optional limit for molybdenum is given, it would apply to either molybdenum alone or molybdenum and tungsten together).

its relevant parts or any other established instrumental/chemical method. In case of dispute the procedure given in IS 228 and its relevant parts shall be referee method. However, where the method is not given in IS 228 and its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

7.2 Elements wherever not quoted in Table 1 shall not be added to the steel, except when agreed to other than for the purpose of finishing the heat and shall not exceed the following limits:

Constituent	Percent, Max
Chromium	0.25
Nickel	0.25
Molybdenum	0.25
Copper	0.35
Vanadium	0.05
Cobalt	0.10
Tungsten	0.25
Tin	0.05

7.3 Check Analysis

The check analysis shall be carried out on the finished product. The permissible variation in the case of such check analysis from the limits specified in Table 1 shall be as given in Table 2.

Table 2 Permissible Variation in Check Analysis
(Clause 7.3)

Element	Permissible Content in Ladle Analysis	Permissible Deviation of Product Analysis
(1)	(2)	(3)
Carbon	Up to 0.50	± 0.02
	Over 0.50 up to 1.45	± 0.03
	Over 1.45 up to 1.90	± 0.04
	Over 1.90	± 0.05
Silicon	Up to 0.90	± 0.03
	Over 0.90	± 0.05
Manganese	Up to 1.00	± 0.04
	Over 1.00 up to 1.70	± 0.06
	Over 1.70	± 0.08
Phosphorus	Up to 0.035	± 0.005
Sulphur	Up to 0.035	± 0.005
Chromium	Up to 2.00	± 0.05
	Over 2.00 up to 2.50	± 0.07
	Over 2.50 up to 11.0	± 0.10
	Over 11.0	± 0.15
Molybdenum	Up to 0.66	± 0.04
	Over 0.66	± 0.05
Vanadium	Up to 0.30	± 0.02
	Over 0.30 up to 0.85	± 0.04
	Over 0.85	± 0.05
Tungsten	Over 0.40 up to 0.80	± 0.04
	Over 0.80 up to 1.70	± 0.05
	Over 1.70 up to 4.50	± 0.07
	Over 4.50 up to 11.50	± 0.10
	Over 11.50 up to 17.0	± 0.15
Nickel	Over 0.5 up to 4.5	± 0.07

NOTE — The deviations, other than when maxima only are specified, apply either above or below the specified limits of the range but not both above and below for the same element from different sample

products, from the same cast. When maxima only are specified, the deviations are positive only. The value are valid only if the samples are selected in accordance with IS 3711 : 1966, so that they represent the average composition of the cross sections of the product.

8 HEAT TREATMENT

8.1 Unless otherwise specified by the purchaser, steels shall be supplied in the annealed condition.

9 HARDNESS

9.1 Steels in the annealed condition, when tested in accordance with IS 1500 : 1983 shall have the Brinell hardness as follows:

Steel Designation	Brinell Hardness (HB) Max	Steel Designation	Brinell Hardness (HB) Max
50T8	210	T30Ni16Cr5	255
55T8	220	T55NiCrMo3	255
60T6	220	T40Ni6Cr4Mo3	255
65T6	220	T31Ni10Cr3Mo6	255
70T6	220	T40Ni10Cr3Mo6	255
75T6	220	T105W6CrV2	230
80T6	220	T110W6Cr4	230
70T3	220	T90Mn6WCr2	230
80T3	220	XT160Cr12	255
85T6	220		
90T3	220	XT215Cr12	255
103T3	220	T55Cr3	230
118T3	220	T55Cr3V2	230
133T3	220	T45Cr5Si3	230
T80V2	220	T50Cr4V2	230
T90V2	220	T55Si7	230
T103V2	220	T55Si7Mo3	230
T118Cr2	220	T40W8Cr5V2	230
T135Cr2	220	T50W8Cr5V2	230
T105Cr5	230	XT33W9Cr3V4	245
T105Cr5Mn2	230	XT35Cr5Mo1V3	235
T140W15Cr2	250	XT35Cr5MoV1	235
T60Ni5	255	XT35Cr5MoW1V3	235
T40Ni14	255	XT55W14Cr3V4	248

10 DIMENSIONAL TOLERANCES

10.1 Tolerance for Dimensions

The dimensional tolerances shall be as follows:

- For hot-rolled products according to Grade 1 or Grade 2 of IS 3739 : 1987 as desired by the customer,
- For forged products according to IS 10604 (Part 1) : 1983 and IS 10604 (Part 2) : 1983,
- For other products according to Tables 3 to 9, and
- Straightness tolerance for cold-finished bars not to exceed 3 mm in any one metre length.

Table 3 Dimensional Tolerances for Cold Drawn Bars — Rounds, Octagons, Quarter Octagons and Hexagons
(Clause 10.1)

Size Range mm (1)	Tolerance mm (2)
Over 6 up to and including 12	± 0.05
Over 12 up to and including 25	± 0.06
Over 25 up to and including 68	± 0.08

Table 4 Dimensional Tolerances for Centreless Ground Bars — Rounds
(Clause 10.1)

Diameter Range (1) mm	Tolerances	
	Under (2) mm	Over (3) mm
From 6 up to and including 12	0.038	0.038
Over 12 up to and including 78	0.051	0.051

Table 5 Dimensional Tolerances for Drill Rod Round Polished or Ground
(Clause 10.1)

Size Range (1) mm	Standard Manu- facturing Tolerance (2) mm	Precision Tolerance (3) mm
Up to and including 0.30	± 0.008	— 0.005
Over 0.30 up to and including 13	± 0.013	— 0.008
Over 13 up to and including 38	± 0.026	— 0.013

Table 6 Dimensional Tolerances for Drill Rod— Shapes Other than Rounds, Cold Drawn
(Clause 10.1)

Size Range (1) mm	Tolerance (2) mm
Up to and including 6	± 0.013
Over 6 up to and including 18	± 0.026
Over 18 up to and including 25	± 0.039

Table 7 Tolerances for Cold Drawn Square and Flat Bars
(Clause 10.1)

Size Range (1) mm	Tolerance (2) mm
Over 6 up to and including 18	± 0.05
Over 18 up to and including 38	± 0.08
Over 38	± 0.10

Table 8 Machined Square and Flat Bars Cold Work Tool Steels
(Clause 10.1)

Size Tolerances		
Dimensions (1) mm	Oversize (2) mm	Tolerance on Oversize (3) mm
Thickness	0.38	+ 0.50 — 0.0
Width	0.38	+ 0.50 — 0.0

Straightness Tolerance : One mm in any one metre.

Table 9 Precision Ground Square and Flat Bars
(Clause 10.1)

Thickness and Width Tolerances		
Thickness (1) mm	Tolerance	
	Under (2) mm	Over (3) mm
Up to and including 6	0.025	0.025
Over 6 up to and including 50	0.05	0.05
Over 12 up to and including 356	0	0.13

10.2 Machining Allowance

The machining allowance shall conform to those given in Tables 10 to 13.

11 SAMPLING

11.1 Sampling for Chemical Analysis

The ladle analysis shall be supplied by the producer. If a product (check) analysis is

Table 10 Minimum Allowances Per Side for Machining for Rounds, Hexagons and Octagons
(Clause 10.2)

All dimensions in millimetres.

Specified Size (1)		Forged (2)	Hot-Rolled (3)	Rounds-Rough Turned (4)	Cold-Drawn (5)
Up to and including 13		—	0.41	—	0.41
Over 13 up to and including 25		—	0.79	—	0.79
„ 25 „ 50		1.83	1.22	—	1.22
„ 50 „ 75		2.39	1.60	0.51	1.60
„ 75 „ 100		3.05	2.24	0.61	2.24
„ 100 „ 125		3.68	2.84	0.81	—
„ 125 „ 150		4.30	3.81	1.02	—
„ 150 „ 200		5.08	5.08	1.22	—
„ 200		5.08	—	1.83	—

NOTE — Maximum decarburization limit is 80 percent of machining allowance per side.

Table 11 Minimum Allowances Per Side for Machining for Forged Square and Flat Bars
(Clause 10.2)

All dimensions in millimetres.

Specified Width

A diagram of a rectangular bar. A horizontal arrow labeled 'A' points to the width of the bar. A vertical arrow labeled 'B' points to the height of the bar.

Over 26 Up to and Including 50	Over 50 Up to and Including 75	Over 75 Up to and Including 100	Over 100 Up to and Including 125	Over 125 Up to and Including 150	Over 150 Up to and Including 175	Over 175 Up to and Including 200	Over 200 Up to and Including 225	Over 225 Up to and Including 250
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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Over 13 up to and including 25) A	1.52	1.65	1.65	1.90	2.03	2.16	2.29	2.54	2.79
Over 13 up to and including 25) B	1.83	2.13	2.54	3.05	3.66	4.27	5.08	5.08	5.08
Over 25 up to and including 50) A	2.29	2.29	2.29	2.54	2.79	2.92	3.18	3.56	3.61
Over 25 up to and including 50) B	2.29	2.54	2.74	3.15	3.76	4.37	5.08	5.08	5.08
Over 50 up to and including 75) A	—	3.05	3.05	3.18	3.30	3.45	3.81	4.06	4.44
Over 50 up to and including 75) B	—	3.05	3.45	3.56	3.76	4.37	5.08	5.08	5.08
Over 75 up to and including 100) A	—	—	3.81	3.81	4.06	4.57	5.08	5.33	5.72
Over 75 up to and including 100) B	—	—	3.81	3.81	4.06	4.57	5.08	5.33	5.72
Over 100 up to and including 125) A	—	—	—	4.57	4.57	4.83	5.33	5.72	6.35
Over 100 up to and including 125) B	—	—	—	4.57	4.57	4.83	5.33	5.72	6.35
Over 125 up to and including 150) A	—	—	—	—	5.33	5.72	5.72	6.35	6.35
Over 125 up to and including 150) B	—	—	—	—	5.33	5.72	5.72	6.35	6.35
Over 150) A	—	—	—	—	—	6.35	6.35	6.35	6.35
Over 150) B	—	—	—	—	—	6.35	6.35	6.35	6.35

NOTE — Maximum decarburization limit is 80 percent of the machining allowance per side.

Table 12 Minimum Allowances Per Side for Machining for Hot Rolled Square and Flat Bars
(Clause 10.2)

All dimensions in millimetres.

Specified Width

A diagram of a rectangular bar. A horizontal arrow labeled 'A' points to the width of the bar. A vertical arrow labeled 'B' points to the height of the bar. The bar is shown with a double-line border.

		Specified Width											
		Up to and Including 13	Over 13 Up to and Including 25	Over 25 Up to and Including 50	Over 50 Up to and Including 75	Over 75 Up to and Including 100	Over 100 Up to and Including 125	Over 125 Up to and Including 150	Over 150 Up to and Including 175	Over 175 Up to and Including 200	Over 200 Up to and Including 225	Over 225 Up to and Including 300	
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Up to and including 13	) A	0.51	0.51	0.61	0.71	0.81	0.91	1.02	1.12	1.28	1.28	1.28
	) B	0.51	0.66	0.81	0.97	1.12	1.37	1.57	1.68	1.98	2.08	2.44
Over 13 up to and including 25	) A	—	0.91	0.91	0.91	1.02	1.12	1.32	1.42	1.52	1.52	1.52
	) B	—	0.91	1.07	1.17	1.42	1.63	2.08	2.29	2.49	2.59	2.74
Over 25 up to and including 50	) A	—	—	1.32	1.32	1.42	1.42	1.52	1.52	1.63	1.73	1.83
	) B	—	—	1.32	1.42	1.52	1.83	2.18	2.49	2.84	3.00	3.10
Over 50 up to and including 75	) A	—	—	—	1.63	1.63	1.73	1.73	1.83	1.83	2.03	2.03
	) B	—	—	—	1.63	1.83	2.08	2.39	2.79	3.10	3.30	3.45
Over 75 up to and including 100	) A	—	—	—	—	2.03	2.03	2.18	2.30	2.39	2.54	2.54
	) B	—	—	—	—	2.03	2.29	2.54	3.05	3.05	3.35	3.81

NOTE — Maximum decarburization limit is 80 percent of machining allowances per side.

Table 13 Minimum Allowances Per Side for Machining for Cold Drawn Square and Flat Bars
(Clause 10.2)

All dimensions in millimetres.

A diagram of a rectangular bar with a double-line border. A vertical arrow labeled 'A' points to the height of the bar. A horizontal arrow labeled 'B' points to the width of the bar.

Specified Width

		Up to and Including 13	Over 13 Up to and Including 25	Over 25 Up to and Including 50	Over 50 Up to and Including 75	Over 75 Up to and Including 100	Over 100 Up to and Including 125
(1)		(2)	(3)	(4)	(5)	(6)	(7)
Up to and including 13	) A	0.64	0.64	0.76	0.89	1.02	1.14
	) B	0.64	0.89	1.02	1.27	1.65	2.03
Over 13 up to and including 25	) A	—	1.14	1.14	1.52	1.40	1.52
	) B	—	1.14	1.27	1.52	1.90	2.41
Over 25 up to and including 50	) A	—	—	1.65	1.65	1.79	—
	) B	—	—	1.65	1.78	2.16	—

NOTE — Maximum decarburization limit is 80 percent of machining allowances per side.

required by the purchaser, at least one sample product shall be taken from each cast.

11.2 Sampling for Brinell Hardness Test

If the material is supplied in the heat-treated condition, one sample product shall be taken from each size grouping from each heat-treatment batch for testing the hardness. If the product is continuously heat-treated, one sample product for each 15 tonnes or part thereof, but at least one sample product for each cast, shall be taken.

12 RETESTS

12.1 Retest for Product Analysis

If the results of the product analysis do not meet the composition requirements given in Table 1 and 7.2, unless otherwise agreed to between the purchaser and the manufacturer, two new samples shall be taken on different pieces from the cast. The two analysis should satisfy the requirements, the lot represented shall be accepted. Should either of the tests fail, the material shall be taken as not complying with this standard.

12.2 Retest Hardness Determination

If the sample selected under 11.2 fails to meet the requirements under 9, two further samples shall be selected from the same heat-treatment batch. The consignment shall be considered to conform to the requirements if both the additional tests are satisfactory. Should either of the samples fail, the manufacturer shall have the right if he so desires to re-anneal the product in any suitable manner before the fresh samples are taken for testing. Should the two tests satisfy the requirements of this standard, the lot represented shall be accepted. Should either of the samples fail, the material shall be taken as not complying with this standard.

13 ULTRASONIC TEST

13.1 All bars/blanks of size 100 mm and above shall be ultrasonically tested for internal soundness (see IS 3664 : 1981) for sizes below 100 mm material may be tested subject to agreement. The acceptance standard shall be mutually agreed to between the purchaser and the manufacturer at the time of enquiry and order.

14 ADDITIONAL TESTS

14.1 Physical tests other than Brinell hardness shall not be usually carried out for the steels

covered in this standard unless specifically called for.

14.2 In addition, the following tests may be carried out to ensure that the steels meet the purchaser's requirements:

- a) Shepherd's P.F. test (penetration fracture for hardenability and grain size);
- b) Fracture disc test (lamination, streak for cleanliness and segregation);
- c) Macro etch test (comparison with standard charts for segregation and porosity) (see IS 11371 : 1985);
- d) Crop test for bars up to 45 mm;
- e) Magnaflux test (see IS 3703 : 1980);
- f) Metallographic test (structure, non-metallic inclusions) (see IS 10138 (Part 1) : 1982, IS 10138 (Part 2) : 1983 and IS 10138 (Part 3) : 1983; and
- g) Distribution of carbides (see IS 12211 : 1988).

NOTE — The standard methods for additional tests given under 14.2 are under preparation. Until these standards are published, methods of tests shall be as agreed to between the purchaser and the manufacturer.

15 SUPPLY CONDITION

15.1 The material may be supplied in any one of the following conditions:

- a) Hot rolled or forged and annealed if required,
 rolled or blast cleaned,
- c) Cold drawn,
- d) Turned or machined,
- e) Rough ground,
- f) Centreless ground, and
- g) Polished for rounds.

16 MARKING

16.1 Each bar over 50 mm diameter or of equivalent cross-sectional areas shall be stamped or suitably marked at the extreme end with the following:

- a) Indication of source of manufacturer, and
- b) The cast number or any other identification mark by which the steel can be traced to the cast from which it was made.

ANNEX A
(Foreword)

BASIS FOR ORDER

A-1 While placing an order for the steels covered by this standard, the purchaser should specify clearly the following:

- | | |
|-------------|-------------------------------------------------------|
| a) Grade; | d) Condition of delivery; |
| b) Quality; | e) Finish; |
| c) Size; | f) Test required; |
| | g) Special requirements, such as binding and packing; |
| | h) Method of manufacture; and |
| | j) Test report, if required. |

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